

Novel Material Systems and Methodologies for Transient Thermal Management

Completed Technology Project (2012 - 2013)



Project Introduction

Advancements in design and development of evaluation methodologies were made in transient thermal testing. Development of multifunctional and thermally switchable systems to address reduced mass and components, and tailored for both structural and transient thermal applications. Active, passive, and novel combinations of the two functional approaches are being developed along two lines of research investigation: switchable systems and transient heat spreading. The approach was to build in thermal functionality to structural elements to lay the foundation for a revolution in the way high energy space systems are designed.

The research team took a fully collaborative approach with NASA, the University of Central Florida, Embry Riddle Aeronautical University, and a global research commercial partner on the development and application of novel materials. Information gained in this study will be leveraged to propose future funding to advance the technology readiness level (TRL) for extreme conditions applications.

The three materials research tasks and associated partners that were explored during this project are summarized as follows:

- A. Two-way Shape Memory Alloys systems with University of Central Florida and NASA Glenn Research Center (GRC)
- B. Gradient Cellular solids with Embry Riddle Aeronautical University
- C. Tunable composites/laminates with NASA-GRC

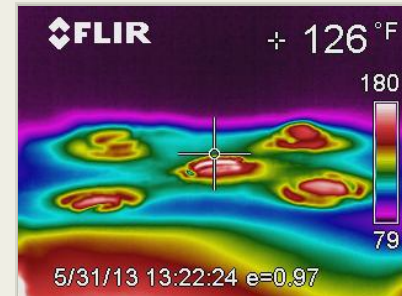
Anticipated Benefits

The benefits to NASA include the following: increased controllability, reduction in energy and power usage, improved thermal management controls, reduced turnaround time, increased system availability, a potential for 50% reduction in cryogenic loading time and reduction in commodity boil-off and helium usage.

This concept is expected to translate to game changing approaches for NASA's exploration and habitations missions, significant reduction in life cycle costs, decreased energy and power consumption, while increasing safety and reliability. The topic of transient thermal management present a wide range of applications and revolutionary approaches to the architectures, designs, and operations of high energy space systems, life support equipment, and human habitats.

Advancement in this technology, such as mass-efficient storage and transfer of cryogenics in space, will aid in meeting the unique thermal requirements of the aerospace industry. Benefits to industries, such as cryogenics, satellites, and commercial aircraft could be realized with this technology.

Benefits to other government agencies are also anticipated to help meet



Thermal Infrared (IR) image of Shape memory alloy (SMA) thermal system during actuation

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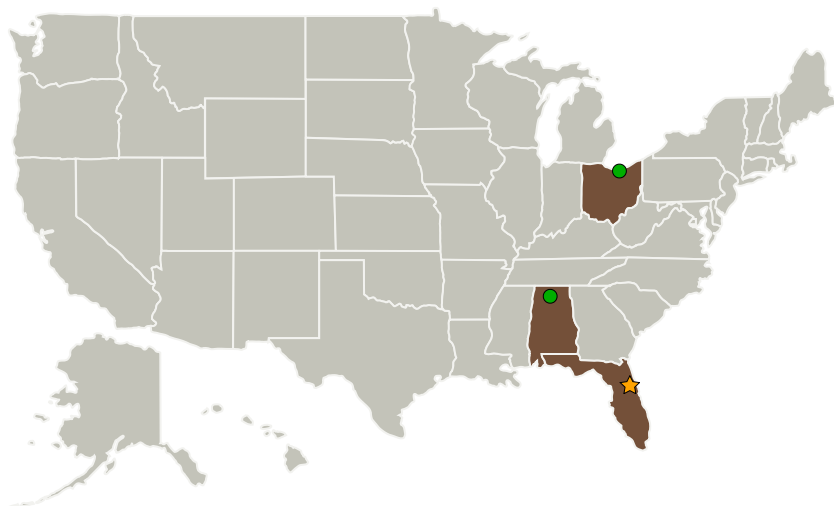
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standards set by Standard Test Methods and Materials Practices (ASTM International).

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Independent Research & Development: KSC IRAD

Project Management

Program Manager:

Barbara L Brown

Project Manager:

Nancy P Zeitlin

Principal Investigator:

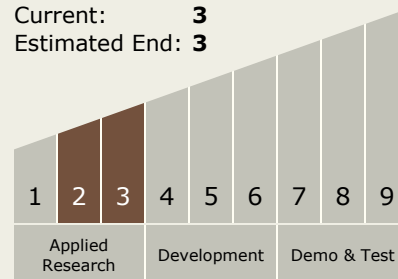
Martha K Williams

Technology Maturity (TRL)

Start: 2

Current: 3

Estimated End: 3



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Organizations Performing Work	Role	Type	Location
★ Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
GE Global Research	Supporting Organization	Industry	Niskayuna, New York
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
● Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama
University of Central Florida(UCF)	Supporting Organization	Academia	Orlando, Florida

Primary U.S. Work Locations

Alabama	Florida
Ohio	

Technology Areas

Primary:

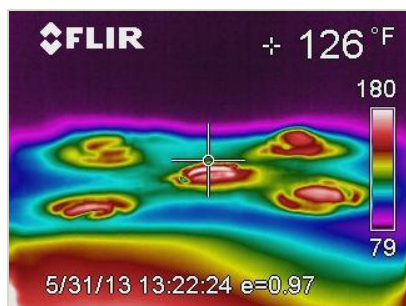
- TX14 Thermal Management Systems
 - └ TX14.1 Cryogenic Systems
 - └ TX14.1.4 Ground Testing & Operations

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Images



Thermal Infrared (IR) image of Shape memory alloy (SMA) thermal system during actuation

Thermal Infrared (IR) image of Shape memory alloy (SMA) thermal system during actuation
(<https://techport.nasa.gov/image/2121>)